Presentation Overview

- Importance of patient temperature management
- CRRT-induced hypothermia
- Homeostasis and core body temperature regulation
- Physiological consequences of hypothermia
- Hypothermia impact on morbidity and mortality
- Preventing CRRT-induced hypothermia
- **PRISMFLO** IIS Blood Warmer
- Recommendations
- References
Importance of Patient Temperature Management
Why Is Patient Temperature Management Important?

- Hypothermia occurs in 40-50% of CRRT patients\textsuperscript{1,2}
- CRRT-induced hypothermia is caused by
  - Exposure of blood in the extracorporeal circuit to ambient temperature for prolonged periods of time\textsuperscript{3,4}
  - Administration of cool dialysate and/or replacement fluids\textsuperscript{3,4}
- Hypothermia risk is increased by sedation, immobility, paralytic drugs, sepsis, underlying endocrine disorders, and higher CRRT dose\textsuperscript{3,4}
- Unintentional hypothermia has negative clinical consequences\textsuperscript{3,4}

\begin{itemize}
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CRRT-Induced Hypothermia
CRRT-Induced Hypothermia Occurs Frequently

- Retrospective study of 595 consecutive CRRT patients
  - 98% CVVH, median duration 4 days
- Replacement fluids were warmed to 38.9 °C (use of online fluid warmer was added if temperature declined)
- Median core temperature decreased by 1.7 °C following institution of CRRT
  - Pre CRRT: 36.9 °C
  - During CRRT: 35.2 °C
- 44% of patients exhibited significant hypothermia (core temperature <35 °C)

Cooling Effect of CRRT in Critically Ill Patients

1. **Retrospective review**
   - 72 consecutive CRRT patients
   - Room temperature dialysate & replacement fluids
   - Hypothermia observed in 38% of sessions
   - Hypothermia > frequent in venovenous modalities
   - Hypothermia occurred in almost 50% of CVVHD patients

2. **Prospective study**
   - 27 CVVHD patients
   - Room temperature dialysate
   - Circuit blood and dialysate temperatures measured at varying flow rates
   - 52% of patients experienced hypothermia
   - Thermal energy loss was increased with slower blood flow rate and faster dialysate rate

Homeostasis and Temperature Regulation

Core body temperature is tightly regulated around 37 °C\textsuperscript{1-2}

Small increases in core temperature $\rightarrow$ heat dissipation\textsuperscript{1-2}
- Sweating and vasodilation

Small decreases in core temperature $\rightarrow$ heat conservation\textsuperscript{1-2}
- Vasoconstriction

Additional decreases in core temperature $\rightarrow$ heat generation\textsuperscript{1-2}
- Shivering

Shivering

• Stimulated by heat receptors in the brain, skin and spinal cord in response to heat loss or sudden cold exposure
• Increases body temperature through muscle contractions
• Muscle contractions significantly increase caloric expenditure and oxygen requirements
• Metabolic rate increases with shivering intensity
• May increase oxygen requirements by 300-400%
• Cardiac and caloric costs of shivering are not well tolerated by the already fragile critically ill patient

Hypothermia Signs & Symptoms

- Body temperature below normal range
- Cool, pale skin
- Dizziness
- Hypertension
- Increased heart rate
- Lack of coordination
- Shivering

Adverse Impact of Hypothermia

- Increased oxygen demand\textsuperscript{1-3}
- Hypoxemia\textsuperscript{1-2}
- Myocardial ischemia\textsuperscript{1-2}
- Changes in cardiac conduction\textsuperscript{1-2}
- Coagulation disorders\textsuperscript{2}
- Deterioration in immune response\textsuperscript{1-3}
- Increased risk of infection, delayed wound healing\textsuperscript{2}
- May mask the presence of fever/infection\textsuperscript{3}
- Patient discomfort\textsuperscript{2}

Inadvertent Hypothermia Increases ICU Mortality

Meta-analysis: 18 studies

- Inadvertent (unintentional) hypothermia significantly increases ICU mortality
  - Mortality doubled when hypothermia was defined as <36.0°C
    - Pooled OR 2.09; 95% CI, 1.70–2.57
  - Mortality tripled when hypothermia was defined as <35.0°C
    - Pooled OR 2.95; 95% CI, 2.17–4.00


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UK NHS Warning: CRRT Hypothermia

Patient Safety Alert issued by NHS in 2014

- Response to 3 incidents in which integrated fluid warmers were switched off and patients received “large volumes of unheated fluid”

- 2 patients experienced severe hypothermia, 1 of whom died

- “…administering unheated fluid for CRRT can rapidly lower patients’ core temperature and returning cool blood to the patient also has detrimental effects on coagulation, the immune system and metabolic function”

Minimizing CRRT-Induced Hypothermia
IV Fluid Warming Does Not Prevent Hypothermia

- Randomized controlled trial to evaluate effectiveness of fluid warmers in preventing hypothermia during CVVHDF
- 60 circuits randomized to IV fluid warmer set at 38.5 °C vs. no fluid warmer
- Patient core temperature was recorded at baseline, then hourly
- Hypothermia was defined as a core temperature <36.0 °C
- Mean core temperature loss did not differ between patients treated with vs. without use of fluid warmer
  - 0.92°C vs. 1.11°C, P = 0.339
- Hypothermia incidence did not differ between patients treated with vs. without use of fluid warmer (P = 0.491)

Table 2. Patient core temperature data (°C)

<table>
<thead>
<tr>
<th></th>
<th>Fluid warmer</th>
<th>No fluid warmer</th>
<th>Total</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (mean)</td>
<td>37.49</td>
<td>37.65</td>
<td>37.57</td>
<td>0.41</td>
</tr>
<tr>
<td>Minimum (mean)</td>
<td>36.57</td>
<td>36.54</td>
<td>36.56</td>
<td>0.87</td>
</tr>
<tr>
<td>Temperature loss (mean)</td>
<td>0.92</td>
<td>1.11</td>
<td>1.01</td>
<td>0.34</td>
</tr>
</tbody>
</table>

PRISMAFLO IIS Blood Warmer

- Used with the PRISMAFLEX System
- PRISMAFLEX System return line is inserted into the groove of the flexible heating sleeve
- Patient’s return blood flow is warmed efficiently, with no increase of extracorporeal blood volume
- Independent sensors monitor temperature for patient safety
- Digital interface shows actual and set temperatures
- Integrated self-test is included
It is important to ensure that the PRISMAFLO IIS Heating Sleeve is dried thoroughly after cleaning.

1. Attachment Device: Attaches the PRISMAFLO IIS Blood Warmer to the holder, which is mounted on the backside of the PRISMAFLEX Control Unit
2. Control Panel: Control buttons and indicators
3. Flexible Heating Sleeve: Transfers heat from the internal heating wire to the medium to be warmed via the inserted blood return line
4. Power Supply Cord: Supplies electricity from the socket to the control unit
5. Connection Cable Heating Sleeve: Connection between control unit and changeable heating sleeve
6. Adaptor of Heating Sleeve: Connection between heating sleeve and cable.
Additional External Warming Is Recommended

CRRT device heating modules may be insufficient to prevent hypothermia, particularly at high doses

- **Passive external rewarming** (covering patient with blankets)
  - Allows normal thermogenesis to increase body temperature
  - Can raise body temperature by 0.5°C/hour
  - Patient shivering mechanism must be intact to be effective

- **Active external rewarming** (warm blankets, heating pads, warm forced air)
  - Can raise body temperature by 1-2.5°C/hour

Recommendations
Patient Temperature Management Recommendations

Be Aware That Hypothermia Is a Common Complication of CRRT

- CRRT-induced hypothermia has been shown to occur in approximately 50% of patients
- Unintentional hypothermia may increase patient morbidity and mortality

Monitor Patient Body Temperature

- Temperature should be monitored at least hourly; patients with a temperature < 36°C should have temperatures monitored continuously

Use Integrated Blood Warmer

- Unwanted hypothermia may be mitigated by using CRRT devices equipped with an integrated blood warmer

Provide Additional External Heating

- Provision of active external heating (heating blankets, warming devices) is recommended

Rx Only: For safe and proper use of products mentioned herein, please refer to the Operator’s Manual or Instructions for Use.

Baxter  USMP/MG120/19-0013  05/19
References
References


Prismaflo IIS System Specification Sheet. 306100438_1 c 2013.07. Gambro Lundia AB.

Prismaflo IIS Quick User Guide. USMP/MG142/16-0002 1000 02/16.


Thank You

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